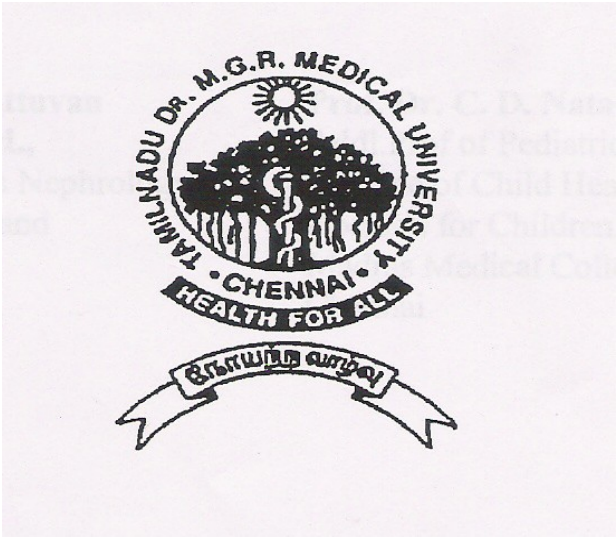
REFERENCE STANDARDS OF ANTHROPOMETRIC MEASUREMENTS FOR ADOLESCENTS 11-18 YEARS OF AGE, OF AN URBAN SET UP

Dissertation Submitted for

M.D. DEGREE EXAMINATION

BRANCH VII – PAEDIATRIC MEDICINE



INSTITUTE OF CHILD HEALTH AND HOSPITAL FOR CHILDREN

MADRAS MEDICAL COLLEGE

THE TAMIL NADU Dr. M.G.R. MEDICAL UNIVERSITY

CHENNAI

MARCH – 2007

CERTIFICATE

Certified that this dissertation entitled **"REFERENCE STANDARDS OF ANTHROPOMETRIC MEASUREMENTS FOR ADOLESCENTS 11-18 YEARS OF AGE, OF AN URBAN SET UP "** is a bonafide work done by **Dr.A. UMASHANKAR,M.D**., Postgraduate student of Paediatric Medicine, Institute of Child Health and Hospital for Children, Egmore, Chennai –8 attached to Madras Medical College, during the academic year 2004-2007.

Prof. Dr. V.T. RAMAKRISHNAN,
M.D., D.C.H.,
Addl. Professor of Paediatrics
Institute of Child Health and ,
Hospital for Children
Madras Medical College
Chennai – 08

Prof.Dr.R. KULANDHAI KASTHURI,
M.D., D.C.H.,
Director and Superintendent,
Institute of Child Health and
Hospital for Children
Madras Medical College
Chennai – 08.

Prof. KALAVATHI PONNIRAIVAN B.Sc., M.D.,
THE DEAN, Madras Medical College,
Chennai - 03

DECLARATION

I declare that this dissertation entitled "**REFERENCE STANDARDS OF ANTHROPOMETRIC MEASUREMENTS FOR ADOLESCENTS 11-18 YEARS OF AGE, OF AN URBAN SET UP"** has been conducted by me at the Institute of Child Health and Hospital for children, under the guidance and supervision of my unit chief.

Prof.Dr. KULANDHAI KASTHURI, M.D., DCH. It is submitted in part of fulfillment of the award of the degree of M.D [Paediatrics] for the March 2007 examination to be held under The Tamil Nadu Dr. M.G.R. Medical University, Chennai. This has not been submitted previously by me for the award of any degree or diploma from any other university.

Dr. A. UMASHANKAR

SPECIAL ACKNOWLEDGEMENT

My sincere thanks to Prof. KALAVATHI PONNIRAIVAN B.Sc., M.D., the Dean, Madras Medical College and Research Institute for allowing me to do this dissertation and utilize the institutional facilities.

ACKNOWLEDGMENT

I would like to express my sincere gratitude to **Prof. Dr. KULANDHAI KASTHURI, M.D.,D.C.H.,** Professor of Paediatrics, Director and Superintendent of Institute of Child Health and Hospital for Children for permitting me to undertake this study.

I am extremely thankful to **Prof Dr. V.T. RAMAKRISHNAN, M.D., D.C.H.,** for his invaluable help, encouragement and support throughout the study.

I would like to thank my unit Assistant Professors of Paediatrics, **Dr. S. RAJENDRAN, M.D., D.C.H., Dr. S. SUNDARI, M.D., D.C.H., Dr. M.S. KALPANA, M.D., D.C.H.,** and **Dr. B. SUMATHI, M.D., D.C.H.,** for their valuable guidance and assistance in doing this work.

I extend my sincere thanks to **Dr. P. RAMACHANDRAN, M.D., D.C.H.,** Registrar for her valuable suggestion and guidance in doing this work.

I would like to thank **Mrs. BASILEA WATSON,** Statistician, Madras Medical College, for her invaluable help.

I Sincerely thank all the adolescents and their parents who had submitted themselves for this study without whom this study would not have been possible.

CONTENTS

INTRODUCTION

Adolescence contributes >20% of total growth in stature and up to 40-50% of body weight as somatic growth. The spurt in somatic growth which is initiated by the sex hormones is accompanied by sexual development. There is marked variation in timing of these maturational changes.

Little is known about the nutritional status of adolescents in both developed and developing countries. One reason for this gap in knowledge is the lack of an internationally agreed on method for assessing nutritional status during this period of life. As in other stages of the life cycle, in adolescence nutritional status is best assessed by using anthropometric measurements. However, the assessment of over nutrition and under nutrition during adolescence is complicated by important changes in body composition, in particular during the puberty – related growth spurt. As a result, much less is known about anthropometry in adolescents than in younger and older age groups. Rapid changes in Somatic growth, problems of dealing with variations in maturation and the difficulties involved in separating normal variations from those associated with health risks to adolescence .[1]

In 1993 World Health Organization (WHO) Expert Committee made provisional recommendations for the interpretation of anthropometric data during adolescence. [2] The Committee recommended the use of the National Centre for Health Statistics (NCHS) reference population to be consistent with the currently

advocated international growth reference for children. These reference data were proposed for identifying individuals and populations at risk, assessing response to interventions and facilitating international comparisons.

ADOLESCENCE – AN OVERVIEW:

This period usually defined by the rapid onset of biological and psychological growth and development prior to or at the second decade of life and ending before age 20. As per the definition of W.H.O, the adolescence as a period between 10 years to 19years of age in both sexes, undergo rapid changes in body size, shape, physiology and psychological and social functioning. Hormones set the developmental agenda in conjunction with social structures designed to foster the transition from childhood to adulthood.

1.2 billion adolescents are living in developing countries making $1/4^{th}$ to $1/5^{th}$ of their countries population. As per W.H.O estimates, adolescents constitute 25% of world population. In India 23% of total population are adolescents making almost 230 million.

Adolescence proceeds across three distinct periods early, middle and late (NCERT 1999) – each marked by a characteristic set of salient biologic, psychological and social issues. However individual variation are substantial, both in terms of the timing of somatic changes and the quality of the adolescent's experience. Gender and subculture profoundly affect the developmental course.

➢ EARLY ADOLESCENCE:

- Defined as adolescents from 10 years to 13 years of age group in both sexes.

- Sexual maturity rating in this age group is around 1 to 2 (prepubertal).
- Secondary sexual characters begin in this group. Growth acceleration also begins in this group.

Sexual interest actually exceeds sexual activity, pre occupied with changing body self-consciousness. Transition from concrete operational thinking of school aged children to form logical operations occur in some of the early adolescence but some acquires this later. Self-consciousness increases exponentially in response to somatic transformations of the puberty. It is normal for the early adolescence to scrutinize their appearance and to feel that everyone else is staring at them too. Girls in particular are at risk of viewing themselves as overweight. Dieting behavior is common and girls who rate themselves as fat or out of shape may be at increased risk of depression. Several body image distortions such as anorexia nervosa are also common in this age group. They often socialize same sex peer groups. Female friendships may center on sharing confidences, where as male relationship may focus more on shared activities and competition. Discordance between chronological age and sexual maturation may increase the stress in early adolescence. Early maturing boys enjoy greater social success and higher self esteem than do those who mature later. For girls by contrast, early maturation is associated with poor school performance and lower self-esteem.

- **MIDDLE ADOLESCENCE**:
  - Defined as adolescents from 14 years to 16 years of age group in both sexes.
- Sexual maturity scoring is around 3 to 5(pubertal).

- Growth accelerates to about the prepubertal linear growth rate of 6-7 cm per year.

  In average, girl growth spurt peaks at 11.5years at a top velocity of 8.3 cm per year and then slows to a stop at 16 yrs. In the average boy, growth spurt starts later, peaks at 13.5 yr at 9.5 cm per year and then slows to a stop at 18 yrs. Weight gain parallels linear growth with a delay of several months, so that adolescents seem first to stretch and then fill out. Pubertal weight gains account for approximately 40% of adult weight. Muscle mass also increases followed by an increase in strength. Boys show greater gain in both lean bodies mass and in strength. Lean body mass approximately 80% in the average prepubertal child increases in boys to 90% and decreases in girls to 75% as subcutaneous fat accumulates. Doubling in of heart size and lung vital capacity occurs when compared preadolescent norms. Blood pressure, blood volume and hematocrit rise particularly in boys. Androgenic stimulation of sebaceous and apocrine glands results in acne and body odor. Physiological increase in sleepiness may be mistaken for laziness.

The timing of menarche appears to be determined by genetics, nutritional status, chronic illness and exercise. Both the sexes will have sexual drive, surges, and sexual experimentation. They will have questions of sexual orientation. Emergence of abstract thought, questioning more occurs in this age group.

They are more concerned with physical attractiveness. Puberty commonly results in strained relationships between adolescents and their parents. As part of separation, adolescents may become distant from parents, redirecting emotional and sexual energies toward peer relationships. Physical attractiveness and popularity remain critical factors in both peer relationships and self esteem.

- **LATE ADOLESCENCE**:

- Defined as adolescents from 17years to 19years of age group in both sexes.
- Somatic changes in this period are modest by comparison.
- The final stages of breast, penile and pubic hair development occur by 17-18yrs of age in 95% of males and females.
- Minor changes in hair distribution often continue for several yeas in males.
- Sexual experimentation decreases as adolescents adopt more stable sexual identities.
- Cognition tends to be less self-centered.
- Slowing of physical changes permits the emergence of a more stable body image.
- In contrast to the often-superficial dating relationships of middle adolescence, these relationships increasingly involve love and commitment. Carrier decisions

become pressing on adolescents because self-concept is increasingly bound up in the emerging role in the society.

PROBLEMS OF ADOLESCENCE:

Most morbidity during adolescence originates from the following categories:

1. Risk taking behaviors
    - Substance use and abuse
    - Unintentional injuries (motor vehicle accidents)
    - Sexual behavior (sexually transmitted diseases, pregnancy in unmarried adolescent girls, illegal abortions)
2. Mental health problems
    - Suicide (more in late adolescents)
    - Depression (more in female)
    - Eating disorders like anorexia nervosa or bulimia nervosa (mostly in post pubertal adolescents)
3. Menstrual problems
    - Polymenorhea
    - Oligomenorhea
    - Metrorrhagia
    - Menorrhagia
    - Dysfunctional uterine bleeding.
4. Over weight
5. Malnutrition

6. Micronutrients deficiency like iron deficiency anemia.

ADOLESCENT NUTRITION:

There is increasing concern about the negative consequences of malnutrition in adolescent girls and young women for their offspring and themselves. Renewed action to address the nutritional problems and needs of adolescents is therefore a priority.

While adolescents have typically been considered a low risk group for poor health, this ignores the fact that many health problems later in life can be improved or avoided by adopting healthy lifestyle habits in adolescence.

There is substantial evidence that inadequate diets affect adolescent's ability to learn and work at maximum productivity. Under nutrition increases the risk of poor obstetric outcomes for teen mothers and jeopardizes the healthy development of their future children. Children born to short, thin women are more likely themselves to be stunted, underweight and less cognitively able than normal birth weight peers. In addition, the heightened obstetric risk caused by stunting in childhood and adolescence persists throughout a woman's reproductive life.

Adolescence is also a unique intervention point in the life cycle. It is a stage of receptivity to new ideas and a point at which lifestyle choices may determine an individual's life course. It offers a chance to acquire knowledge about optimal nutrition during young adulthood that could prevent or delay adult-onset diet-related illnesses later on. Potentially, the inclusion of adolescent boys in nutrition and healthy lifestyle programs will contribute to the improved nutrition and health of

women during childbearing and for infants and young children in the critical early years of life.

Attention needs to be directed at the link between adolescent nutrition and immediate and long-term health issues, including the cost effectiveness of addressing adolescent nutrition, so that the political commitment to support an action agenda can be secured.

AIM OF THE STUDY

To construct reference percentile charts for height, weight and body mass index of school going adolescents aged 11-18 years in Chennai urban set-up and to find out age specific prevalence of stunting and obesity and comparing it with National Centre for Health Statistics (NCHS) reference data.

REVIEW OF LITERATURE

De Onis M, Dasgupta P, Saha S, Sengupta D, Blossnur M. The National Centre for Health Statistics reference and the growth of Indian adolescent boys". American Journal of clinical Nutrition, Vol.74, No.2, 248-253,

August 2001.

1. A cross – sectional anthropometric survey was conducted in Bengali boys from middle class families. The NCHS reference data on height and body mass index (BMI) were used to estimate age-specific prevalence of stunting and overweight.
2. They observed the prevalence of stunting to be about 8.2% and that of overweight at 4.2%, which is low compared to the NCHS data.
3. The concluded that NCHS data seem inadequate for this sample and consideration should be given to developing appropriate reference data based on healthy adolescent populations from different ethnic groups. Issues of maturation – related variation in assessing growth during adolescence should be given particular attention.

Official 2000 Centres Disease Control (CDC) growth charts & percentile charts by NCHS

1. It was constructed from data accumulated from USA. It may not represent children from developing countries.

2. There is no certainty that the growth of NCHS data base is optimal – they may well be too fat; and bigger is not necessarily better.

3. In most of the developing countries growth failure in children is widespread and severe. Estimates of malnutrition on the basis of NCHS reference would, therefore, "Overestimate" the true extent of the problem.

4. Health planners may find targets based on NCHS standards unrealistic and unattainable.

WORLD HEALTH ORGANIZATION, Physical status : the use and interpretation of anthropometry.

Report of a WHO Expert Committee. World Health Organ Tech Rep. Ser. 1995; 854

1. WHO growth charts for international use was developed by reviewing the charts from various regions from both developed and developing countries.

2. The interpretation of weight curve on the service chart must be made in relation to five reference lines on the weight grid. The channels formed by those lines were labeled with the letters A,B,C,D,E,F for purposes of identification of nutritional status of the children. It proposes that each country should decide from existing local data, which of these channels best represents the current status of most of the population.

3. In this report WHO opines that countries or regions might eventually develop local reference standards; in the interim these reference lines should provide an effective substitute.

Agarwal KN, Saxena A, Bansal AK, Agarwal DK

Physical growth assessment in adolescence. Department of pediatrics, University college of Medical sciences, Delhi.

1. Measurements were recorded in healthy affluent school going adolescents in public schools of 12 cities in India (boys – 11,863 and girls – 7, 694)

2. Means and percentiles of BMI and skin – fold thicknesses at yearly intervals were derived for each sex and relating to sexual maturity.

3. They concluded that Multicentric BMI and anthropometry data will provide data for correlating the health consequences and assessing the secular trend.

Agarwal dl, Agarwal ICN, Upudhyay Sr 1992

Indian Pediatrics 1992, 24-1203-1282. Physical and sexual growth pattern of affluent Indian children.

1. This study was done in 1992 in affluent adolescent population in New Delhi.

2. This study set-up new percentiles and growth reference charts for all populations.

3. It concluded that NCHS data is inappropriate for the Indian population.

JUSTIFICATION OF STUDY

An understanding of ethnic differences in growth is essential to identifying the extent to which a single reference can be applied worldwide. The similarities in attained growth in preschoolers from developed and affluent developing country populations seem to have settled this controversial issue for the younger age group[1,2]. In adolescent populations, however, the current evidence is not sufficient to disentangle the contribution of genetic from that of environmental influences on growth. Data on secular trends in both developed and developing countries show a marked intergenerational increase in size and a tendency toward earlier sexual maturation as the socioeconomic conditions and nutritional status of populations improve. This secular trend has fundamental implications for the development of anthropometric reference data. As long as such a trend exists, the data will eventually become obsolete. The prescriptive approach taken for the construction of a new international growth reference for young children should also be applicable to older children and adolescents. This would imply developing a reference based on healthy adolescent populations from different ethnic groups in which secular trends exist.

Numerous studies done on adolescent growth in North India and other parts of India found that the National center for Health Statistics (NCHS) data to be inappropriate to our population. This studies also showed a secular trend of puberty

in India related to the improvement in socio-economic conditions and nutritional status of the adolescents.

In India short stature and low BMI (Body mass Index) may be determinants of concurrent functional impairment due to reduced lean body mass, changes in muscle metabolism and deficiencies in muscular strength and working capacity and reduction in higher mental functions.

On the other side, upper extremes of BMI causes hypertension, insulin resistance, hypercholesteremia and adult morbidity and mortality.

So, as cautioned by WHO, it is high time now that we construct our new percentile charts for height, weight and BMI and set standards for Chennai urban adolescent population and compare it with NCHS data.

This study was planned with the aim of constructing reference standards for anthropometric measurements for our population.

SUBJECTS AND METHODS

- **STUDY DESIGN** : Descriptive Cross Sectional Study.
- **PLACE OF STUDY** : Corporation Schools and government aided schools in Chennai Corporation.
- **STUDY PERIOD** : March 2005-October 2006.
- **STUDY POPULATION**
  - Inclusion Criteria :
    - Corporation School going adolescent boys and girls aged 11-18 years.
  - Exclusion Criteria :
    - Children with systemic illness and/or any significant illness in recent past.
    - Students with major dysmorphology or signs of physical deformity.
- **SAMPLE SIZE**
  - The prevalence of obesity among girls in a previous study was 3.2%. Accusing a precision of 2% with 2 error of 5%, the sample size was calculated to be 300 in each age group of each gender.

- Using the previous study and in consultation with statistician, the sample size was calculated to be 300 in each age group of each gender.
- Total Sample Size : 5100

- **SAMPLING TECHNIQUE**:

  Stratified random sampling.

MANEUVER

Chennai Corporation was divided into 4 regions. (viz East, West, North, South) Representative samples was drawn for the Age strata of one year from 11-18 years adolescent boys & girls attending corporation and Government aided Schools from all regions of Chennai.

Their date of birth was confirmed from school records. Informed consents from parents was obtained and they were requested to fill-up the proforma to assess their socio-economic status. Consent from School Headmaster and Chief Educational Officer (Chennai Corporation) was also acquired for the study purposes.

Their anthropometric measurements of height and weight were measured accurately. To avoid observational errors, mean of three measurements were taken

HEIGHT MEASUREMENT

Height was recorded to the nearest centimeter by using anthropometer rod with the students head held in erect position.

Mean of three measurements taken by different observers was taken for study purpose.

Readings are measured with an accuracy of upto 0.1 cm.

WEIGHT MEASUREMENT

Weight was measured by a lever actuated balance to the nearest 0.5 kg.

Boys were allowed to wear light pants only without shoes.

Girls were measured with their school uniforms without shoes.

Mean on three measurements, taken by different observers was taken for the study purpose.

CALCULATIONS

To assess stunting during adolescence the indicator and cut off value are $<3^{rd}$ percentile or <-2z scores of height for age.

BMI in relation to age or BMI for age is recommended as the best indicators for overweight and obesity.

BMI is calculated as $\frac{\text{weight in kg}}{(\text{Height in meters})^2}$

BMI $>85^{th}$ percentile is considered as overweight. Obesity is taken as more than 95^{th} percentile of BMI.

BMI (kg/m^2) and height for age scores were calculated for each individual. The age-specific prevalence of stunting and obesity was calculated according to the recommendations made by the WHO Expert Committee[2].

STATISTICAL ANALYSIS

All results were tabulated and percentage was arrived by using windows MS Excel application and analysis was performed by using SPSS version 11.0 Software. Descriptive statistics like frequencies and percentage were obtained.

RESULTS

Samples were tabulated age wise and sex wise Results were tabulated for weight for Age, Height for age and BMI for Age.

No. of Adolescents enrolled :

Total	-	5100
Boys	-	2500
Girls	-	2600

WEIGHT FOR AGE

The percentile chart of weight for age for boys and girls are presented in Table 1 & 2 respectively.(mean value of NCHS data is given in parentheses)

In age group of 11-14, 325 boys were included in each age group and in age group 15-18, 300 boys were included.

325 girls were included in all age groups 11-18.

The 50th percentile and mean value of weight for age in boys was marginally higher than girls in the age group of 11-15 years. In the age group of 16-18, girls had higher 50th percentile and mean value than boys.

TABLE – 1

BOYS WEIGHT FOR AGE PERCENTILES

PERCENTILE								
Age (Years)	**Number**	**3**	**10**	**25**	**50**	**75**	**90**	**97**
11	325	27.9	35.8	39.7	35.8 (36.07)	49	54.3	58.6
12	325	32.1	35.1	38.4	39.2 (40.67)	47.7	54.4	61
13	325	33.8	36.8	41.1	42.3 (45.81)	51.1	59.4	63.2
14	325	34.8	38.5	42.5	43.6 (51.23)	52.7	58.9	68.6
15	300	39.2	41.7	45.2	47.4 (56.49)	56.5	65.7	73.2
16	300	41.8	43.5	47.8	48.3 (61.1)	60.2	69.5	74.1
17	300	43.9	45.7	48.4	49.4 (64.7)	62.9	68.6	74.2
18	300	43.9	46.5	51.7	52.6 (67.29)	64.5	74.7	74.9

TABLE - 2

GIRLS WEIGHT FOR AGE PERCENTILES

		PERCENTILE						
Age (Years)	**NUMBER**	**3**	**10**	**25**	**50**	**75**	**90**	**97**
11	325	19.2	21.3	24.7	30.1 (37.3)	33.2	36.2	38.2
12	325	22.5	24.6	27.2	32.1 (41.8)	36.4	38.3	40.1
13	325	24.6	25.7	28.4	33.4 (45.9)	38.6	39.6	41.2
14	325	27.1	28.6	31.2	36.3 (49.4)	39.6	41.2	43.2
15	325	29.2	30.8	33.4	38.3 (52.14)	42.3	44.1	45.4
16	325	31.1	33.4	35.8	48.5 (53.9)	50.2	53.8	59.2
17	325	33.2	35.6	38.1	51.2 (55.1)	53.4	56.2	61.2
18	325	34.6	36.3	39.2	53.8 (56.2)	55.6	57.8	63.5

At 11 years of age, the 50th percentile for boys were 35.8 and 3rd, 25th, 90th, 97th percentile were 27.9, 39.7, 54.3 and 58.6 respectively. For girls at this age group, the 50th percentile was 30.1. The 3rd, 25th, 97th percentiles were 19.2, 24.7 & 38.2 respectively.

At 12 years age group, the 50th percentile of weight for age for boys is 39.2. The 3rd, 25th and 97th percentiles were 32.1, 35.1 & 61 respectively. For girls at 12 years the mean value was 32.1. The 3rd, 25th, 97th percentiles were 22.5, 27.2 and 40.1 respectively.

At 13 years age group, the 50th percentile and mean value for boys was 42.3. The 3rd, 25th and 97th percentiles were 33.8, 41.1 & 63.2 respectively. The girls mean value was 33.4. The 3rd, 25th, 97th percentiles were 24.6, 28.4 & 41.2 respectively.

At 14 years, the mean value or 50th percentile for boys was 43.6. The 3rd, 25th and 97th percentiles were 34.8, 42.5 & 68.6 respectively. For girls, the 50th percentile was 36.3. The 3rd, 25th, 97th percentiles were 27.1, 31.2 & 43.2 respectively.

At 15 years, the mean value or 50th percentile for boys was 47.4. The 3rd, 25th and 97th percentiles were 39.2, 45.2 & 73.2 respectively. The mean for girls was 38.3. The 3rd, 25th, 97th percentiles were 29.2, 33.4 & 45.4 respectively.

At 16 years, the mean value for boys was 48.3. The 3rd, 25th and 97th percentiles were 41.8, 47.8 & 74.6 respectively. The 50th percentile is higher for girls at 48.5. The 3rd, 25th, 97th percentiles were 31.1, 35.8 & 59.2 respectively.

At 17 years, the 50th percentile or mean value for boys was 49.4. The 3rd, 25th and 97th percentiles were 43.9, 48.4 & 74.2 respectively. For girls the mean was higher at 51.2. The 3rd, 25th, 97th percentiles were 33.2, 38.1 & 61.2 respectively.

At 18 years, the mean value for boys was 52.6. The 3rd, 25th and 97th percentiles were 43.9, 51.7 and 74.9 respectively. For girls, the mean was higher at 53.8. The 3rd, 25th, 97th percentiles were 34.6, 39.2 & 63.5 respectively.

HEIGHT FOR AGE

The percentile charts of height for age for boys and girls are presented in Table 3 & 4 respectively.(Mean value of NCHS data is given in parentheses)

In age group of 11-14, 325 boys were included in each age group and in age group 15-18, 300 boys were included.

For girls, 325 girls were included in all age groups 11-18.

At all age points, boys mean height for age was found to be higher than girl

TABLE:3
BOYS HEIGHT FOR AGE PERCENTILES

		PERCENTILE						
Age (Years)	**Number**	**3**	**10**	**25**	**50**	**75**	**90**	**97**
11	325	138.8	139.8	140.1	143.7 (143.7)	161.3	163	166
12	325	143	143.8	145.4	146.8 (149.3)	162.5	167	168.9
13	325	147	151.5	153.2	154.2 (156.4)	165	168.5	172.6
14	325	148.5	154	158	162.6 (164.1)	167.5	171.2	174.8
15	300	154	157	161	165.5 (170.1)	169.3	172.8	176.2
16	300	156.5	159	162.5	165.7 (173.6)	171.5	175	178.9
17	300	160.3	161	164.1	167.8 (175.3)	173.7	177.5	184.3
18	300	157.5	163.8	166.5	170 (176.2)	173	177.9	183.2

TABLE - 4

GIRLS HEIGHT FOR AGE PERCENTILES

		PERCENTILES							
Age (Years)	NUMBER	3	5	10	25	50	75	90	97
11	325	115.8	116.5	119.4	123.2	127.1 (144.3)	131.6	133.4	135.8
12	325	119.2	119.5	122.1	126.5	130.8 (151.5)	135.8	139.2	143.2
13	325	124.1	124.5	127.2	131.2	136 (157.3)	141.2	145.3	148.6
14	325	128.2	130.5	130.8	134.66	138.3 (160.5)	144.6	149.2	151.5
15	325	131.3	131.6	133.2	136.8	140.2 (161.9)	1466.8	150.1	153.6
16	325	132.1	132.5	134.6	138.3	142.1 (162.6)	148.6	151.8	154.8
17	325	133.1	133.2	135.1	139.6	143.6 (162.9)	150.1	153.2	155.2
18	325	133.8	134.3	135.8	139.8	144.8	151.2	155.4	158.5

(163.1)

At 11 years of age, the 50th percentile or mean value of height for age for boys was 143.7. The 3rd, 25th, 97th percentiles were 138.8, 140.1 & 166 respectively. The mean value for girls was 127.1. The 3rd, 25th, 97th percentiles were 115.8, 123.2 & 135.8 respectively.

At 12 years of age, the mean value for boys was 146.8. The 3rd, 25th, 97th percentiles were 143, 145.4 & 188.9 respectively. The mean value for girls was 130.8. The 3rd, 25th, 97th percentiles were 119.2, 126.5 & 143.2 respectively.

At 13 years, the mean value for boys was 154.2. The 3rd, 25th, 97th percentiles were 147, 153.2 & 172.6 respectively. The mean value for girls was 131.2. The 3rd, 25th, 97th percentiles were 124.1, 131.2 & 148.6 respectively.

At 14 years, the mean value for boys was 162.6. The 3rd, 25th, 97th percentiles were 148.5, 158 & 174.8 respectively. The mean value for girls was 138.3. The 3rd, 25th, 97th percentiles were 128.2, 134.66 & 151.5 respectively.

At 15 years of age, the mean value for boys was 165.5. The 3rd, 25th, 97th percentiles were 154, 161 & 176.2 respectively. The mean value for girls were 140.2. The 3rd, 25th, 97th percentiles were 131.3, 136.8 & 153.6 respectively.

At 16 years of age, the mean value for boys was 165.7. The 3rd, 25th, 97th percentiles were 156.5, 162.5 & 178.9 respectively. For girls, the mean value were 142.1. The 3rd, 25th, 97th percentiles were 132.1, 138.3 & 154.8 respectively.

At 17 years of age, the mean value for boys was 167.8. The 3rd, 25th, 97th percentiles were 160.3, 164.1 & 184.3 respectively. For girls, the mean value for girls were 143.6. The 3rd, 25th, 97th percentiles were 133.1, 139.6 & 155.2 respectively.

At 18 years of age, the mean value for boys was 170. The 3rd, 25th, 97th percentiles were 157.5, 166.5 & 183.2 respectively. For girls, the mean value for girls were 144.8. The 3rd, 25th, 97th percentiles were 133.8, 139.8 & 158.5 respectively.

BODY MASS INDEX FOR AGE

The BMI for age percentiles were calculated and is given for boys and girls in Tables 5 & 6 respectively. (Mean value of NCHS data is given in parantheses)

The mean value of BMI for age for boys is lower than girls in all age groups of 11-18 years.

At 11 years of age, the mean for boys was 16.6 and for girls it was 17.5. The comparable 95th percentile for boys and girls was 23.4 and 24.5 respectively.

At 12 years of age, the mean for boys and girls was 17.1 & 18.4 respectively. The comparable 95th percentile for boys and girls was 23.8 and 25.7 respectively.

At 13 years of age, the mean for boys and girls was 17.7 & 19.2 respectively. The comparable 95th percentile for boys and girls was 25.3 and 27.1 respectively.

At 11 years of age, the 50th percentile or mean value of height for age for boys was 143.7. The 3rd, 25th, 97th percentiles were 138.8, 140.1 & 166 respective.

Table - 5

BOYS BMI FOR AGE PERCENTILES

				PERCENTILES						
Age (Years)	**Number**	**Mean**	**S.D.**	**5**	**10**	**25**	**50**	**75**	**85**	**95**
11	325	16.6 (17.2)	2.71	13.3	13.8	14.7	15.8	17.6	19.1	23.4
12	325	17.1 (17.8)	2.72	13.6	14.2	15.2	16.4	18.3	19.8	23.8
13	325	17.7 (18.5)	3.03	14	14.5	15.5	17.1	19	20.4	25.3
14	325	18.2 (19.2)	2.9	14.5	15.1	16.3	17.7	19.6	21.1	25.3
15	300	19.2 (19.9)	3.12	15.4	15.9	16.9	18.4	20.5	22	27.3
16	300	19.7 (20.6)	3.09	15.8	16.5	17.4	19.1	21.1	22.7	27.6
17	300	20.1 (21.2)	2.83	16.3	16.9	17.8	19.7	21.5	24.4	26.8
18	300	20.4	3.36	15.7	16.8	17.8	20	22.5	23.6	28

(21.9)

Table - 6

GIRLS BMI FOR AGE PERCENTILES

				PERCENTILES						
Age (Years)	**Number**	**Mean**	**S.D.**	**5**	**10**	**25**	**50**	**75**	**85**	**95**
11	325	17.5 (17.5)	3.1	13.5	14.1	15.2	16.9	19	20.6	24.5
12	325	18 (18.5)	3.2	13.9	14.6	15.9	17.8	20.1	21.9	25.7
13	325	19.2 (19.4)	3.6	14.6	15.3	16.7	18.6	21	22.6	27.1
14	325	19.7 (19.8)	3.2	15.4	16	17.3	19	21.4	23	27.4
15	325	20 (20.1)	3.3	15.9	16.5	17.7	19.3	22	23.6	27.7
16	325	20.5 (20.5)	3.2	15.9	16.6	18.1	20	22.4	23.7	28.1
17	325	20.6 (20.9)	3.1	16.6	16.9	18.3	20.1	22	23.9	28.2
18	325	20.9	3.2	16.9	17.9	18.3	20.2	23	24.1	28.4

(21.3)

At 15 years of age, the mean for boys and girls was 19.2 & 20 respectively. The comparable 95th percentile for boys and girls was 27.3 & 27.7 respectively.

At 16 years of age, the mean for boys and girls was 19.7 & 20.5 respectively. The comparable 95th percentile for boys and girls was 27.6 & 28.1 respectively.

At 17 years of age, the mean for boys and girls was 20.1 & 20.6 respectively. The comparable 95th percentile for boys and girls was 26.8 & 28.2 respectively.

At 18 years of age, the mean for boys and girls was 20.4 & 20.9 respectively. The comparable 95th percentile for boys and girls was 28 & 28.4 respectively.

Table – 7

BOYS STUNTING PERCENTILES

11	N Percentiles	VALID Missing 3	325 20 138.8	6.15%
12	N Percentiles	VALID Missing 3	325 20 143.0	6.15%
13	N Percentiles	VALID Missing 3	325 19 147.0	5.85%
14	N Percentiles	VALID Missing 3	325 18 148.5	5.54%
15	N Percentiles	VALID Missing 3	300 16 154	5.33%
16	N Percentiles	VALID Missing 3	300 18 156.5	6%
17	N Percentiles	VALID Missing 3	300 12 160.3	4%
18	N Percentiles	VALID Missing 3	300 12 157.5	4%
TOTAL	135 2500	5.4%		

STUNTING PERCENTILES FOR BOYS

The stunting percentiles for age for boys is illustrated in Table 7.

The values that full below 3rd percentile in height for age is taken as stunted.

Out of the Sample population of 2500 about 135 boys are stunted.

The Stunting prevalence in boys is 5.4%

The highest rate of stunting is found in the age group of 11 & 12 years where 6.15% are stunted.

At 13 years of age, 5.85% are stunted.

At 14 years about 5.54% are stunted.

At 15 years the stunting prevalence is about 5.33%

At 16 years, it again peaks at 6%

At 17 & 18 years, the stunting prevalence is roughly the same at about 4%

STUNTING PERCENTILES FOR GIRLS FOR AGE

The stunting percentiles for age for girls is illustrated in Table 8.

The value of height for age that full below 3rd percentile is taken as stunted

Out of the sample population of 2600. 169 girls are stunted.

The stunting prevalence in girls is 6.5%. The highest rate of stunting is found in the age group of 11 years at about 7.69% and lowest at 18 years of 5.54%.

At 12 & 13 years of age, the stunting prevalence is 7.08%.

Table - 8

GIRLS HEIGHT STUNTING PERCENTILES

11	N	VALID	325	7.69%
		Missing	25	
	Percentiles	3	116.8	
12	N	VALID	325	7.08%
		Missing	23	
	Percentiles	3	119.2	
13	N	VALID	325	7.08%
		Missing	23	
	Percentiles	3	124.6	
14	N	VALID	325	6.15%
		Missing	20	
	Percentiles	3	128.2	
15	N	VALID	325	5.85%
		Missing	19	
	Percentiles	3	131.3	
16	N	VALID	325	6.15%
		Missing	20	
	Percentiles	3	132.1	
17	N	VALID	325	6.46%
		Missing	21	
	Percentiles	3	133.1	
18	N	VALID	325	5.54%
		Missing	18	

	Percentiles	3	133.8	
TOTAL				6.5%

At 14 years of age, the prevalence is 6.15%. The prevalence at 15 years of age dips down to 5.85% and it once again reaches the value of 14 years at 16 years of age.

At 17 years, the prevalence is at about 6.46%

COMPARISON OF STUNTING PERCENTILES OF BOYS AND GIRLS

The Comparison bar diagram of stunting percentiles of boys and girls in illustrated in fig 1. Fig:2 shows the proportional prevalence of stunting in Boys and Girls.

Girls of all ages 11-18 years have increased prevalence of stunting when compared to boys.

The Prevalence of stunting in boys is 5.4% compared to 6.5% of girls.

Both Boys & girls have their maximum stunting percentiles at early adolescence and stunting percentiles decrease considerably in late adolescence

FIGURE:1

COMPARISON BETWEEN BOYS STUNTING PERCENTILE AND GIRLS STUNTING PERCENTILE AGE WISE

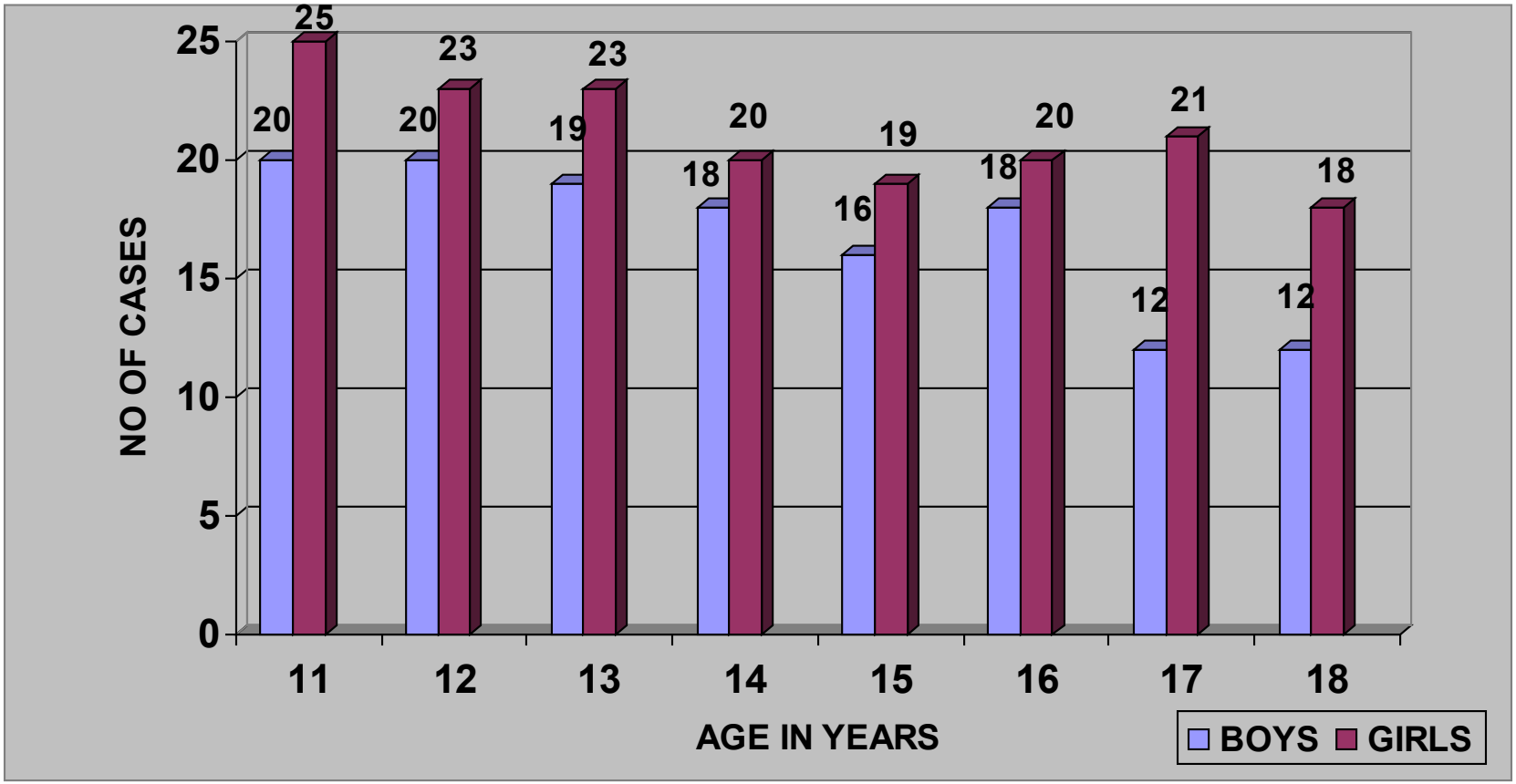
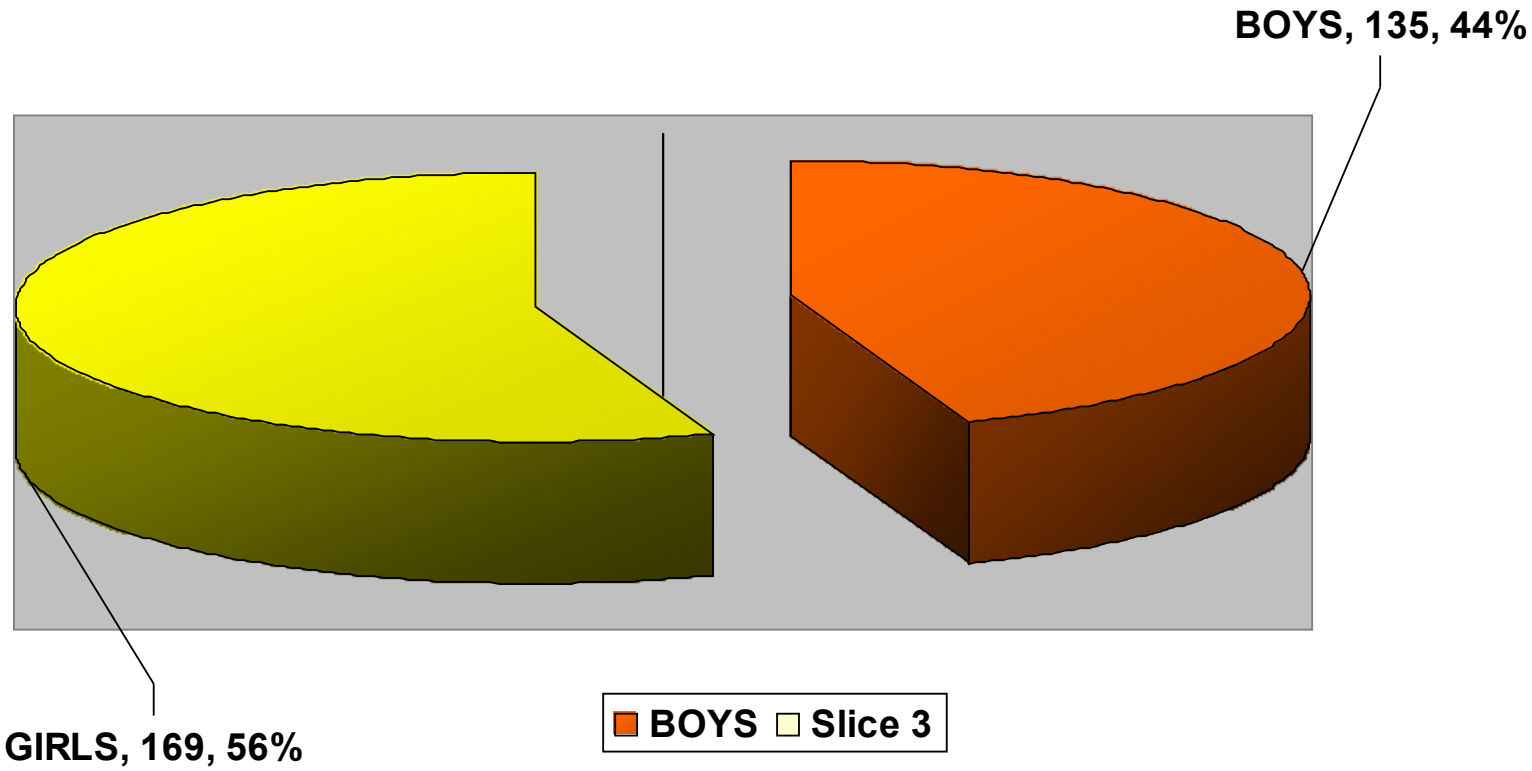


FIGURE:2

COMPARISON BETWEEN BOYS AND GIRLS STUNTING PREVALENCE



BOYS OBESITY PERCENTILES FOR AGE

The boys obesity percentiles are tabulated in Table No.9.

Among 2500 sampled population 120 of them were found to be obese.

The overall prevalence of obesity amount among adolescent boys of age group 11-18 years is 4.8%

The maximum prevalence of obesity occurs at about 18 years of age with prevalence of 8%.

The minimum prevalence occurs at 11 years of age with prevalence of 2.46%.

At 12 years the obesity prevalence is 2.77% and 3.38% at 13 years.

The steadily increases throughout adolescence and is 4%, 5%, 6% at 14,15 and 16 years respectively.

The obesity prevalence at 17 years still increases and is about 7.33%

Table – 9

BOYS OBESITY PERCENTILES

SEX	AGE (Years)		OBESE	NORMAL	TOTAL
MALE	11	COUNT % WITH AGE	8 2.46%	317 97.54%	325 100%
MALE	12	COUNT % WITH AGE	9 2.77%	316 97.23%	325 100%
MALE	13	COUNT % WITH AGE	11 3.38%	314 96.61%	325 100%
MALE	14	COUNT % WITH AGE	13 4%	312 96%	325 100%
MALE	15	COUNT % WITH AGE	15 5%	285 95%	300 100%
MALE	16	COUNT % WITH AGE	18 6%	282 94%	300 100%
MALE	17	COUNT % WITH AGE	22 7.33%	278 92.67%	300 100%
MALE	18	COUNT % WITH AGE	24 8%	276 92%	300 100%
TOTAL			120 4.8%	2380 95.2%	2500 100%

GIRLS OBESITY PERCENTILES FOR AGE

The Girls obesity percentiles for age are tabulated in table No.10.

Amount 2600 sampled population about 240 girls were found to be obese.

The prevalence rate of obesity among adolescent girls aged 11-18 years is 9.23%.

The prevalence of maximum obesity is at about 18 years of age with 17.23%

There is wide variation in prevalence with only 0.92% of adolescent girls are obese at age 11 years.

The prevalence of obesity is almost equal in 12 & 13 years at about 4.61%

The steadily increases through out adolescence to about 7.69%, 11.08% and 12.31% at 14, 15 and 16 years respectively.

At 17 years of age, the prevalence of obesity is around 15.38%

Table - 10
GIRLS OBESITY PERCENTILES

SEX	AGE		OBESE	NORMAL	TOTAL
FEMALE	11	COUNT % WITH AGE	3 0.92%	322 99.08%	325 100%
FEMALE	12	COUNT % WITH AGE	15 4.61%	310 95.38%	325 100%
FEMALE	13	COUNT % WITH AGE	15 4.61%	310 95.38%	325 100%
FEMALE	14	COUNT % WITH AGE	25 7.69%	300 92.31%	325 100%
FEMALE	15	COUNT % WITH AGE	36 11.08%	289 88.92%	325 100%
FEMALE	16	COUNT % WITH AGE	40 12.31%	285 87.69%	325 100%
FEMALE	17	COUNT % WITH AGE	50 15.38%	275 84.61%	325 100%
FEMALE	18	COUNT % WITH AGE	56 17.23%	269 82.77%	325 100%
TOTAL			240 9.23%	2360 90.77%	2600 100%

COMPARISON OF OBESITY PERCENTILES FOR AGE FOR BOYS AND GIRLS

The comparison bar diagram of obesity percentiles of boys & girls is illustrated in fig. 3. Figure 4 shows proportional prevalence of obesity in both Boys and Girls.

The prevalence of obesity percentiles in boys is 4.8% whereas in girls it is much higher at 9.23%

Only at 11 years of age, the prevalence of obesity is less for girls at 0.92% whereas for boys it is 2.46%

In all other age groups the prevalence of obesity is much higher in girls than in boys.

FIGURE:3

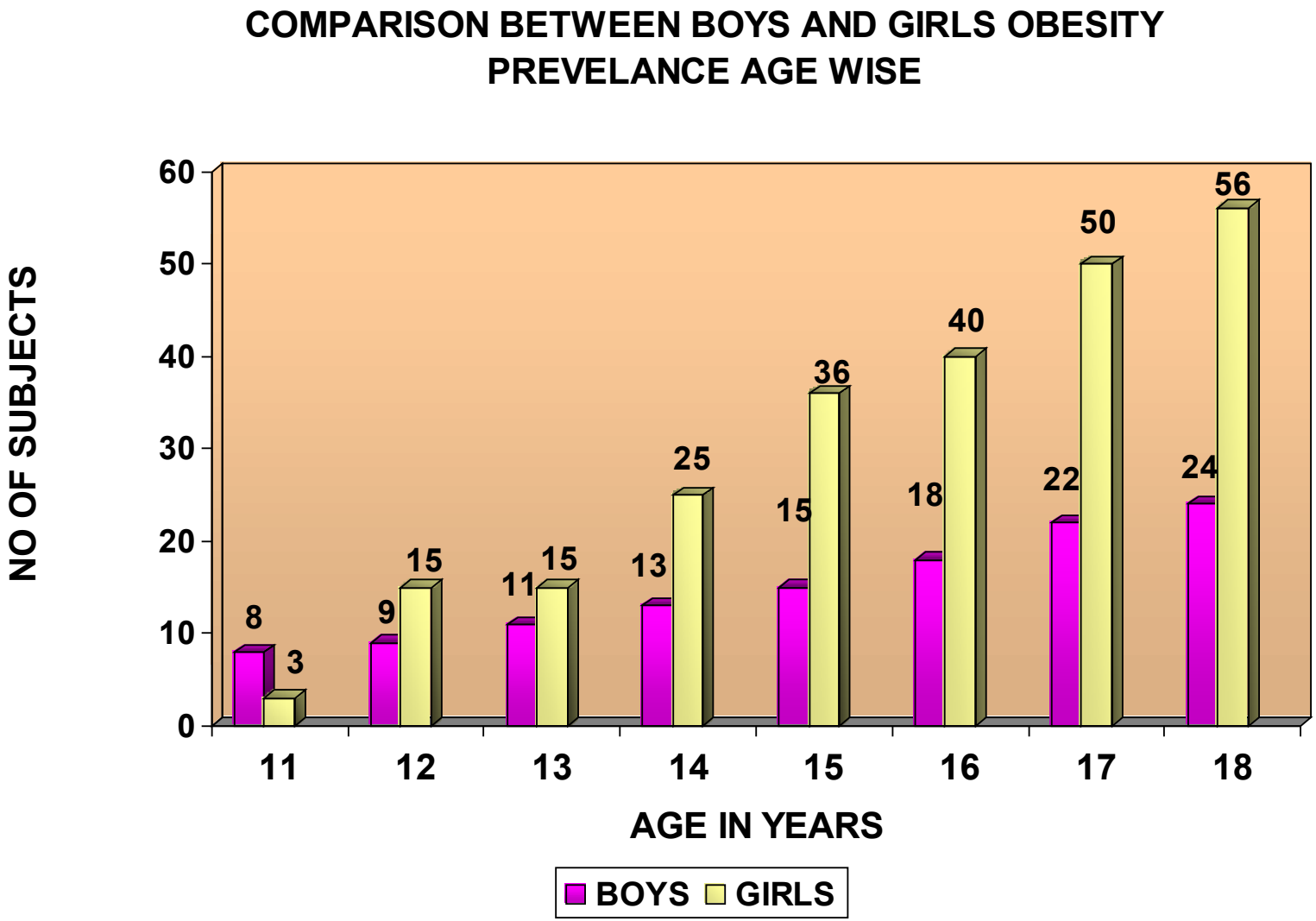
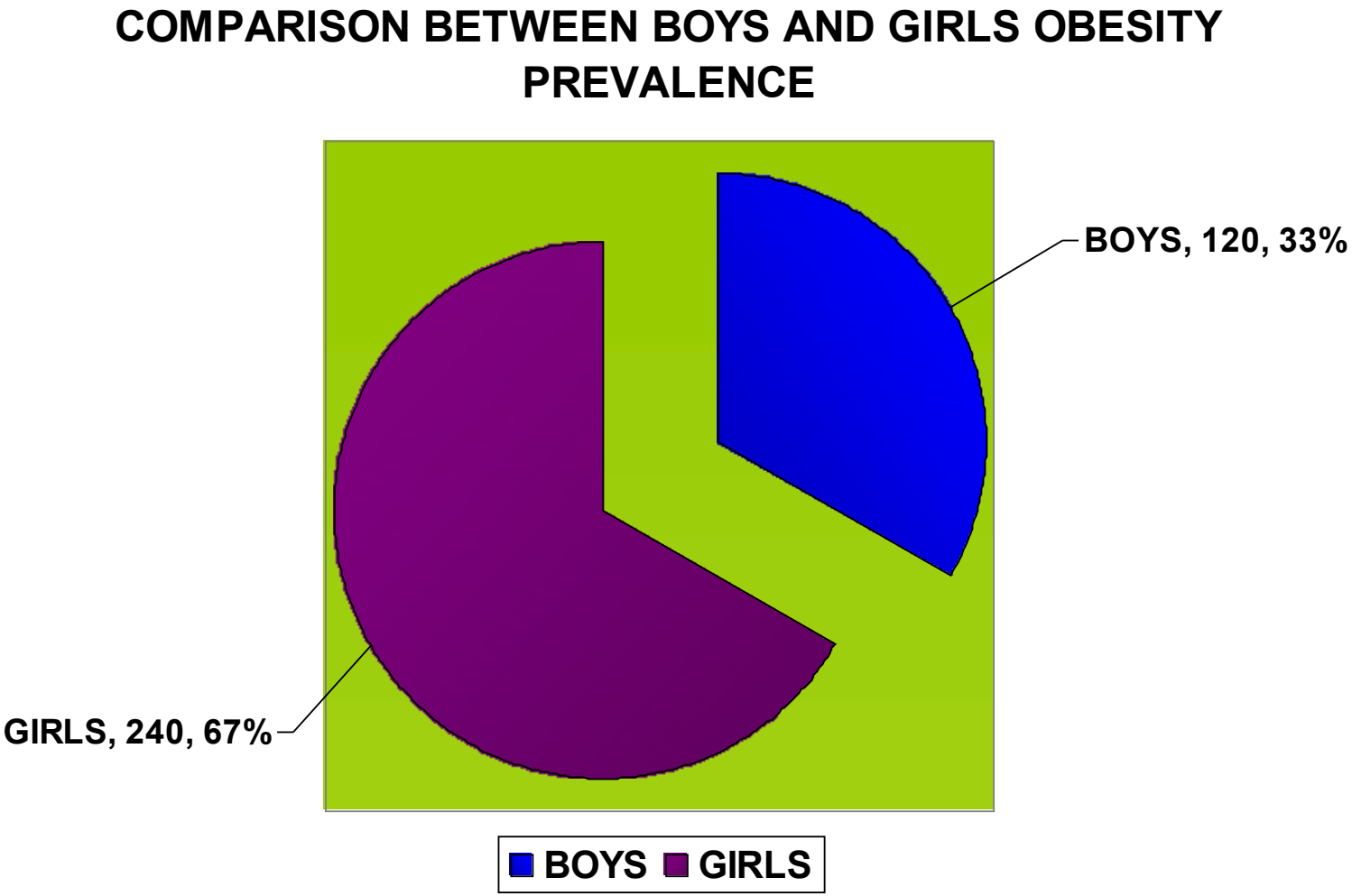

COMPARISON BETWEEN BOYS AND GIRLS OBESITY PREVELANCE AGE WISE
NO OF SUBJECTS
60
50
40
30
20
10
0
8
3
9
15
11
15
13
25
15
36
18
40
22
50
24
56
11
12
13
14
15
16
17
18
AGE IN YEARS
BOYS
GIRLS

FIGURE:4


COMPARISON BETWEEN BOYS AND GIRLS OBESITY PREVALENCE
BOYS, 120, 33%
GIRLS, 240, 67%
BOYS
GIRLS

COMPARISON OF HEIGHT FOR AGE FOR BOYS WITH NCHS DATA

The comparable 5th percentiles for height for age for boys with NCHS data is tabulated in Table No.11.

Comparable 5th percentile in this study is low in all age groups when compared with NCHS curves.

When this 5th percentile of NCHS data, is applied to our population, the stunting prevalence in boys increases to about 11.2% i.e. 11.2% boys are undernourished according to their standards.

Table – 11

(COMPARABLE 50TH PERCENTILE OF HEIGHT FOR AGE FOR BOYS)

Age (Years)		Present Study	NCHS
11	50th Percentile	143.7	143.7
12	50th Percentile	146.8	149.3
13	50th Percentile	154.2	156.4
14	50th Percentile	162.6	164.1
15	50th Percentile	165.5	170.1
16	50th Percentile	165.7	173.6
17	50th Percentile	167.8	175.3

18	50th Percentile	170	176.2

COMPARISON OF HEIGHT FOR AGE FOR GIRLS WITH NCHS DATA.

The Comparable 5th percentile for height for age for girls with NCHS data is tabulated in Table No.12

Comparable 5th percentile derived from this study, is low in all age groups when compared to NCHS data.

When this NCHS data, is applied to our population, the stunting prevalence in girls of our population increases to about 15.2% which is unacceptable.

Table – 12

COMPARABLE 50TH PERCENTILE OF HEIGHT FOR AGE FOR GIRLS

Age (Years)		Present Study	NCHS
11	50th Percentile	127.1	144.3
12	50th Percentile	130.8	151.5
13	50th Percentile	136	157.3
14	50th Percentile	138.3	160.5
15	50th Percentile	140.2	161.9
16	50th Percentile	142.1	162.6
17	50th Percentile	143.6	162.9

18	50th Percentile	144.8	163.1

COMPARISON OF WEIGHT FOR AGE FOR BOYS WITH NCHS DATA

The comparable 50th percentile of weight for age for boys in this study is compared to NCHS data on Table No.13

In all age groups, the 50th percentile is less when compared with NCHS data.

Table - 13

COMPARABLE 50TH PERCENTILE OF WEIGHT FOR AGE PERCENTILES OF BOYS

Age (Years		Present Study	NCHS
11	50th Percentile	35.8	36.07
12	50th Percentile	39.2	40.67
13	50th Percentile	42.3	45.8
14	50th Percentile	43.6	51.2
15	50th Percentile	47.4	56.49
16	50th Percentile	48.3	61.1
17	50th Percentile	49.4	64.7
18	50th Percentile	52.6	67.2

COMPARISON OF WEIGHT FOR AGE FOR GIRLS WITH NCHS DATA

The comparable 50th percentile of weight for age for girls in this study is compared to NCHS data on Table No.14

In all age groups, the 50th percentile of study population is less when compared with NCHS data.

Table - 14

COMPARABLE 50TH PERCENTILE OF WEIGHT FOR AGE FOR GIRLS

Age (Years)		Present Study	NCHS
11	50th Percentile	30.1	37.3
12	50th Percentile	32.1	41.8
13	50th Percentile	33.4	45.9
14	50th Percentile	36.3	49.4
15	50th Percentile	38.3	52.1
16	50th Percentile	48.5	53.9
17	50th Percentile	51.2	55.1

18	50th Percentile	53.8	56.2

COMPARISON OF BMI FOR AGE FOR BOYS WITH NCHS DATA

The mean for BMI for age boys from this present study is compared to NCHS data in Table No.15.

Table – 15

COMPARABLE MEAN BMI FOR AGE FOR BOYS

Age (Years)		Present Study	NCHS
11	MEAN BMI	16.6	17.2
12	MEAN BMI	17.1	17.8
13	MEAN BMI	17.7	18.5
14	MEAN BMI	18.2	19.2
15	MEAN BMI	19.2	19.9
16	MEAN BMI	19.7	20.6

17	MEAN BMI	20.1	21.2
18	MEAN BMI	20.4	21.9

COMPARISON OF BMI FOR AGE FOR GIRLS WITH NCHS DATA

The for BMI for age for Girls from this present study is compared to NCHS data in Table No:16.

The Mean BMI for Age for Girls is less than mean in NCHS data for all age groups.

Table – 16

COMPARABLE MEAN BMI FOR AGE FOR GIRLS

Age (Years)		Present Study	NCHS
11	MEAN BMI	17.5	17.5
12	MEAN BMI	18.4	18.5

13	MEAN BMI	19.2	19.4
14	MEAN BMI	19.7	19.8
15	MEAN BMI	20	20.1
16	MEAN BMI	20.5	20.5
17	MEAN BMI	20.6	20.9
18	MEAN BMI	20.9	21.3

DISCUSSION

India is a signatory of millennium development goals by 2020 and marches towards the achievement of goals. Health planners and policy makers allocate resources towards health care based on nutritional status of the population. There is no proper data available to estimate the nutritional status of adolescents. This puts a question mark over the ability of our country millennium development goals by 2020. To achieve this good health planning based on nutritional status is important.

Assessing nutritional status in adolescents continues to be a challenge. To tackle this problem, there is a need for studies of the adolescent growth and maturation characteristics of well-nourished populations from different ethnic backgrounds conducted with use of a common protocol. This vital information may lead to a better understanding of the growth and biological maturation that takes

place during puberty. Only with this acquired knowledge can we develop valid guidelines for assessing nutritional status during adolescence. These guidelines will then need to be validated by using functional indicators such as morbidity, work capacity, reproductive outcomes and mortality.

Increase in body size is a biological phenomenon that can be readily observed and easily measured, even under the simplest conditions. In man, the patterns of physical growth in an individual or community are the result of genetic characteristics and environmental influences, among which infectious disease and

dietary in take are of particular importance in the developing areas of world. The frequency with which this type of measurement is used has given rise to a wide variety of systems for recording and interpreting data, ranging from complex research grids incorporating several variables to simple charts indicating weight-for-age.

The standards used for purpose of comparison vary widely as do the systems for classification of growth deviation, not only from country to country but among areas within the same country. The proliferation of charts, standards and systems of classification has given rise confusion in health services as to which is the most desirable for local use as well for regional and international comparisons.

Habicht et al[10] stated that there are small differences 3% for height and 6% for weight in different ethnic groups with similar socio-economic status. In

contrast, the varying socio-economic status can have higher difference (12% for height and 30% for weight). Therefore, these workers recommended that both genetic and ecologic background as well as their mutual interaction be taken into account in the construction of growth references.

Goldstein and Tanner [11], Tanner [12] have argued for local standards, which need to be updated from time to time to account for changing socio-economic level.

The use of western standards set unattainable goal and overestimate degree of under nutrition among children. The same could be avoided using local attainable standards [13, 14]

Vanloon et al[15] working in 4 different geographical areas showed that growth curves had heterogeneity as well as the values had varying differences as compared to NCHS [1] standards for individual age points.

In our country, adolescent growth is usually estimated using NCHS[1] charts.

The 50th weight for centile for boys upto 15 years approach around 10-25th percentile and between 5th – 10th percentile for age 16-18 years compared to NCHS Standards [1]. For girls, the 50th weight centile of the present is rear 25-50th centile upto 15 years, thereafter upto 18 years between 10-25th centile compared to NCHS[1] standards.

In height for age the 50th percentile line for 60th boys and girls of this study fall below the 10th percentile line of the NCHS growth chart [1].

Similarly the 95th percentile line of this study full below the 75th percentile line of the NCHS growth chart[1]. Study by Agarwal et al[3] and Dasgupta P et al [4].

The stunting prevalence of boys in the present study is found to be 5.4% comparable to national standards by studies conducted by Agarwal et al [3] Stunting prevalence in girls was marginally higher at 6.5% when compared to national standards.

The obesity prevalence of adolescent boys in the present study is found to be 4.8% which is marginally higher than the 4.2 prescribed by national level studies conducted by Agarwal et al [3]. Similarly the prevalence of obesity among girls was found to be 9.23% which is much higher when compared to boys.

This prevalence of obesity is higher when compared to national standards which is 6.5%. This increase in BMI reflects changing secular trends.

Rosner et al [7] have documented significant ethnic variations in BMI. There was therefore need to establish normal reference for BMI and stunting during adolescence. Secondly well nourished Indian children over the past two decades are showing an increasing trend in somatic and physical growth as established by anthropometric measurements[8]. In Britain, new anthropometric standards were developed in 1990, but less than a decade later it has become evident that these standards no longer reflect the distribution of weight in British school children [9]. In another study in India Kaur and Singh [13], also observed higher BMI an well nourished Delhi girls.

Thus, it would be said that Growth level attainable in India be used on regional basis to avoid overestimate of under nutrition. The changing secular trends should also be borne in mind while assessing anthropometric measurements.

The need for continuous efforts to collect data for growth parameters in a nation-wide and regional approach will ultimately provide an assessment measured for optimal growth potential.

CONCLUSION

- The 50th percentile for weight for age, height for age and BMI for age were comparatively lower for both adolescent boys and girls aged 11-18 years when compared to NCHS data.
- The stunting prevalence of boys was found to be 5.4% comparable to national standards but in girls the stunting prevalence was marginally higher at 6.5%.
- The obesity prevalence of boys was found to be 4.8% marginally higher than the national standard of 4.2%. In girls, the prevalence of obesity was found to be 9.23% higher than the national standards of 6.5%.
- These changes reflects the changing secular trends at the regional level.
- Keeping changing secular trends in mind, continuous efforts to collect data for growth parameters in both national and regional level should be done.
- It is recommended to use the growth charts developed from this study for the Chennai population to monitor the nutritional status of adolescents and to identify children who are really malnourished.

BIBLIOGRAPHY

1. Official 2000 centers for disease control (CDC) growth charts and percentile charts by NCHS. Ww.cd.gov/growth charts.

2. WHO, Physical status : the use and interpretation of anthropometry. Report of a WHO Expert committee. World Health Organ Tech Rep. Ser 1995; 854

3. Physical growth assessment in adolescence.

   Agarwal KN, Saxena A, Bansal AK, Agarwal DK, PMID : 11721062

4. The National Centre for Health Statistics reference and the growth of Indian addescent boys.

   De Onis M, Dasagupta P, Saha S, Sengupta D, Blossner M, American Journal of clinical nutrition, Vol.74, No.2, 248-253, August 2001.

5. Nelson textbook of Pediatrics, 17th edition, Chapter 14 Page 53-58.

6. Nelson textbook of pediatrics, 17th edition, Chapter 15.

   The Assessment of Growth, Page 58-61.

7. Percentiles for body mass index in OS Children 5 to 17 years of age. Rosner et al, Prineas R, Loggie S, Daniels SR J.Pediater 1998; 132; 211-222.

8. Physical and growth pattern of affluent Indian children from 5-18 years of age.

Agarwal OK, Agarwal KN, Upadhyay SK, Mittal R, Indian Pediatr 1992; 29: 1203-1211.

9. Anthropometric measure in British adolescent population of 10-18 years.

David et al, BMJ, 1990; Page No.911-923.

10. Anthropometric reference data for international use : recommendation from a World Health Organization Expert Committee.

De Onis M, Habicht JP. AMJ din Nutr 1996; 64 : 650-8

11. Goldstein H, Tanner JM, Ecological considerations in the creation and use of child growth standards.

Lanut 1980, 1:582-585

12. Tanner JM, use and abuse of growth standards Vol.3, 3rd edn, New York, 1986, pp 95-109.

13. Anthropometric measures in affluent Indian adolescent girls Kaur and Singh et al Indian Pediatr 1998; Page No.110-115.

14. Indian council of Medical Research Growth and physical development in adolescent, New Delhi 1972.

15. Vanloon H, Sayerys U, Vuylsteke E, Vlietinck RF, Feckles R.

Local versus universal growth standards; The effect of using NCHS as universal reference. Ann Hum Bio1 1986, 13:347-357.

16. IAP text book of paediatrics: Chapter 4 : Growth and Development, page 73-100.

ANNEXURE – I

PROFORMA

Name of the Student Age Sex D.O.B.

School Religion Caste

Location of the School

Residential Address of the Student

Father's Name Age Educational Qualification Occupation

Mother's Name Age Educational Qualification Occupation

If other Siblings Present / Particulars

Monthly income of the family / per capital income

Residential Particulars

Type of House Sanitation Drinking Water

Socio economic status (Acc to Kuppusamy scale)

Any History of Major illness / recent Hospitalization

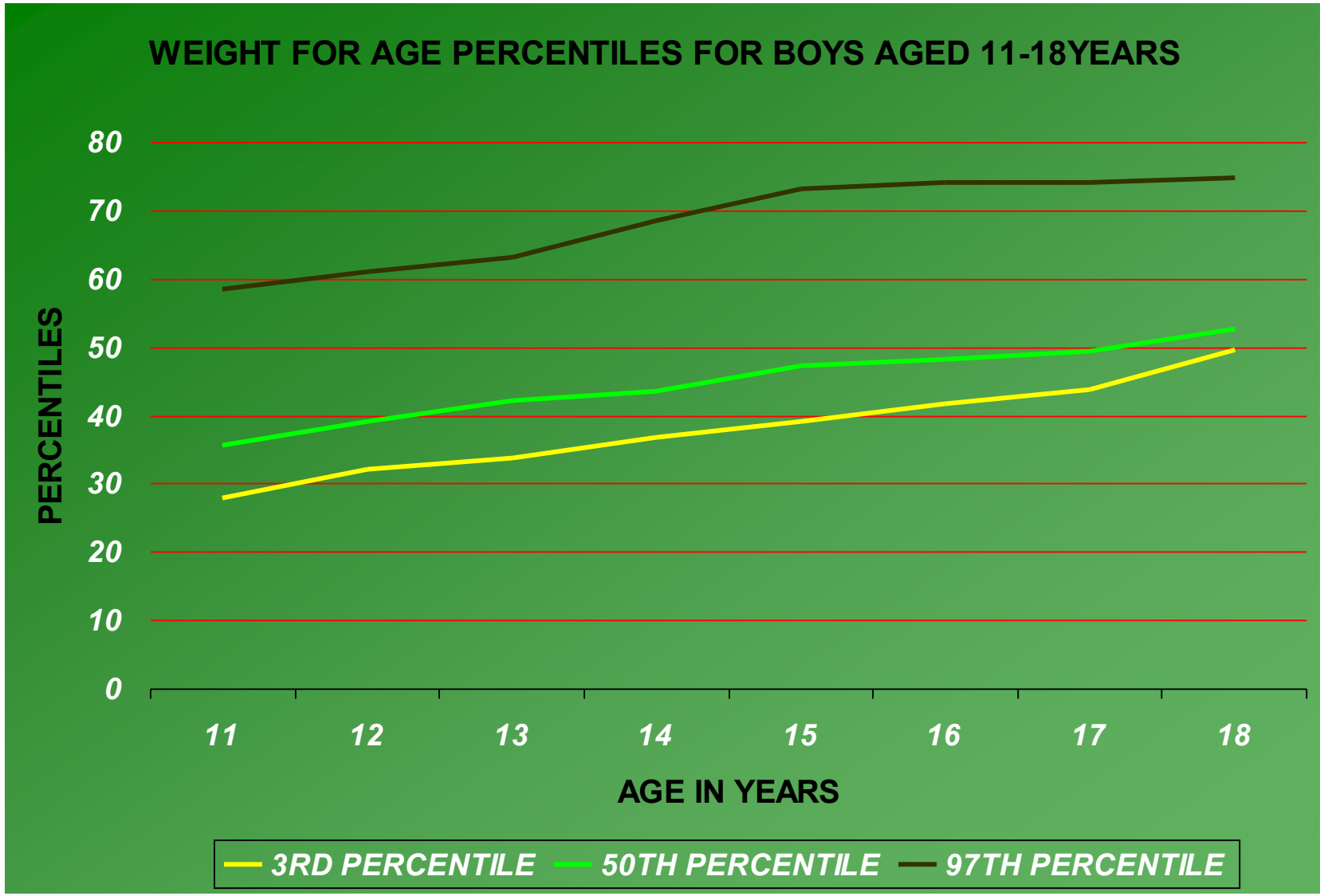
Anthropometry Measurements BMI (Kg/ms)

Height		Weight	
	1		1
	2		2
	3		3
Avg.	Avg.		

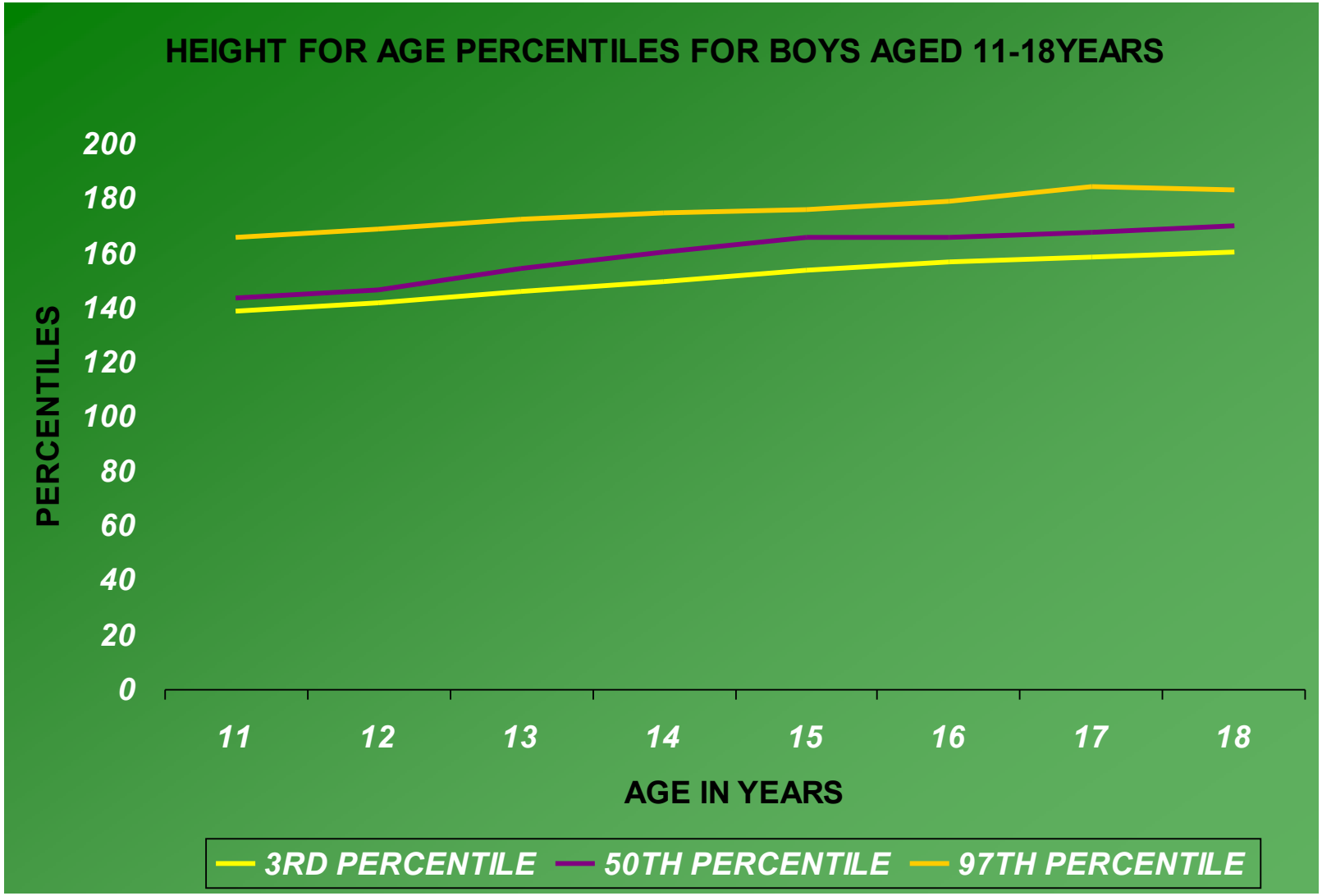
Signature of the school headmaster Signature of the student

Signature of the investigator

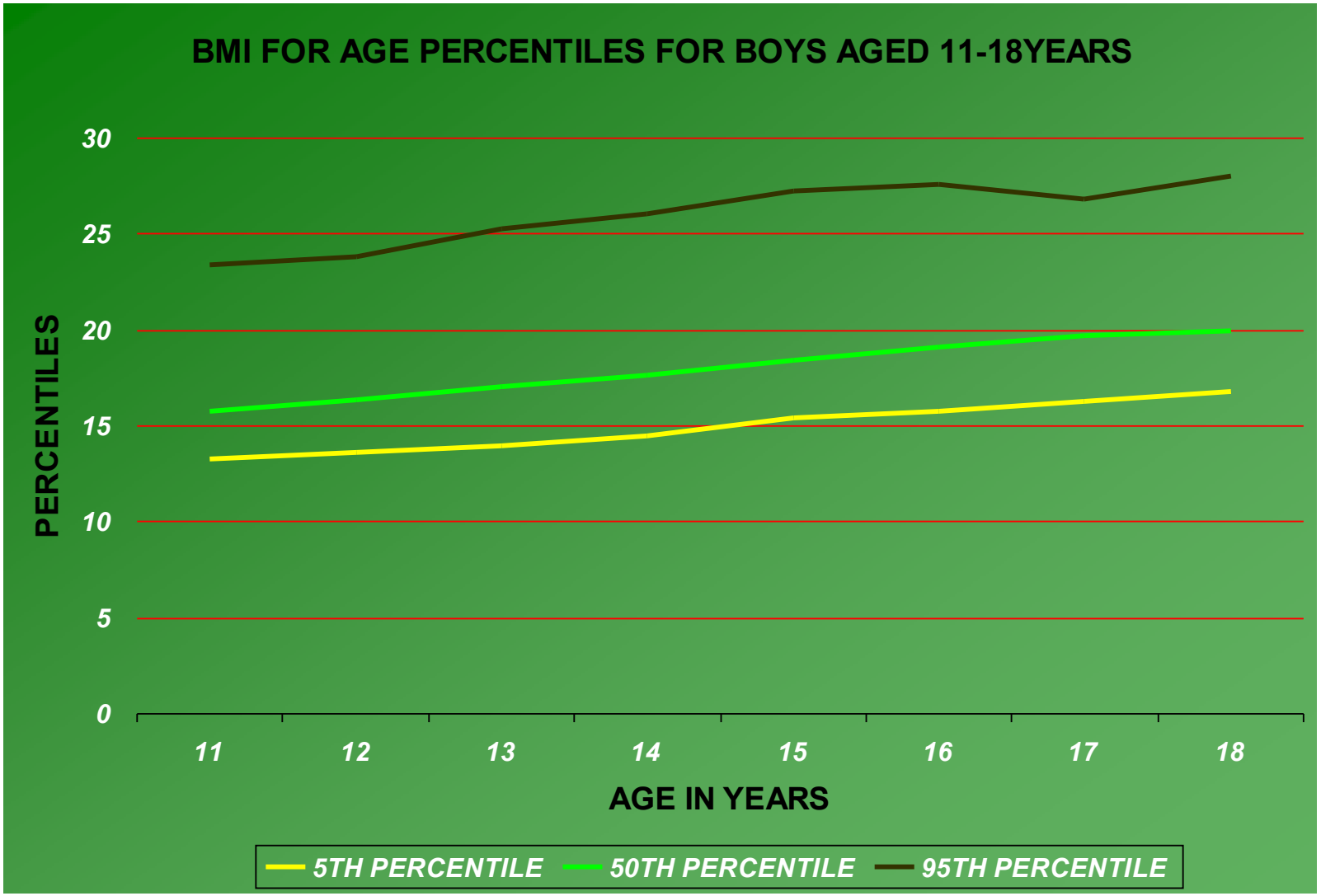
ANNEXURE – II


WEIGHT FOR AGE PERCENTILES FOR BOYS AGED 11-18YEARS
PERCENTILES
80
70
60
50
40
30
20
10
0
11
12
13
14
15
16
17
18
AGE IN YEARS
3RD PERCENTILE
50TH PERCENTILE
97TH PERCENTILE

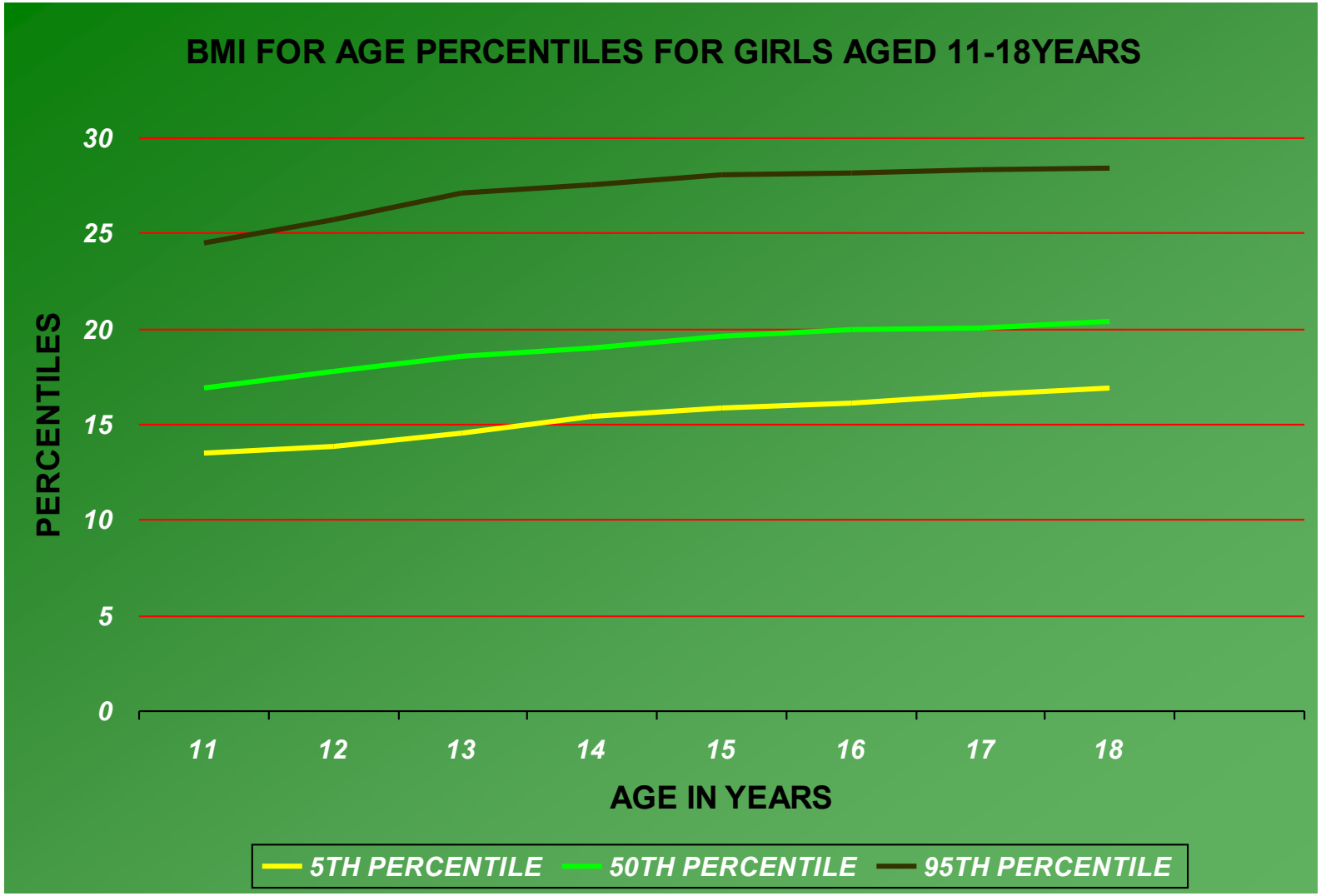
ANNEXURE – III



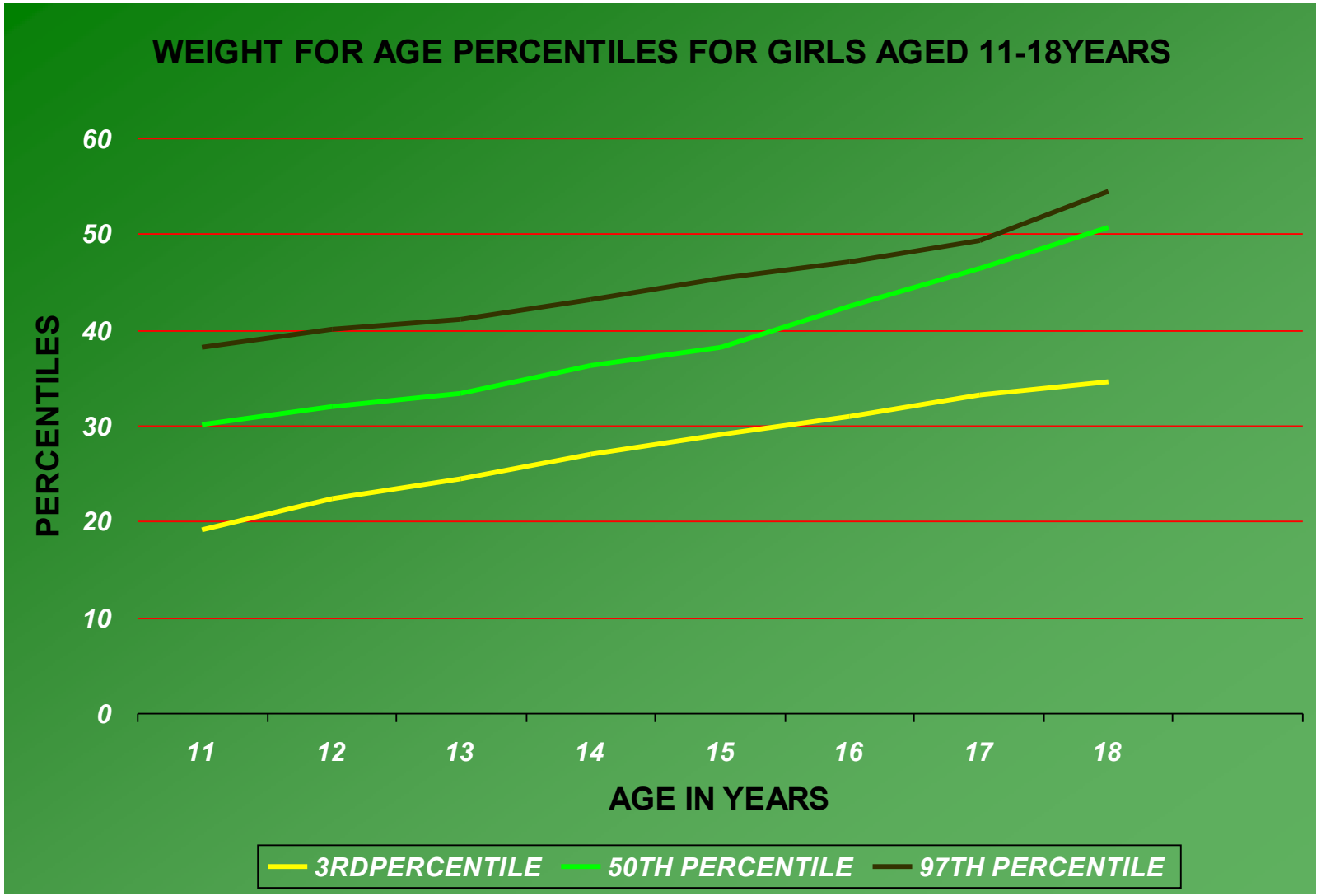
ANNEXURE – IV


BMI FOR AGE PERCENTILES FOR BOYS AGED 11-18YEARS
PERCENTILES
30
25
20
15
10
5
0
11
12
13
14
15
16
17
18
AGE IN YEARS
5TH PERCENTILE
50TH PERCENTILE
95TH PERCENTILE

ANNEXURE V


BMI FOR AGE PERCENTILES FOR GIRLS AGED 11-18YEARS
PERCENTILES
30
25
20
15
10
5
0
11
12
13
14
15
16
17
18
AGE IN YEARS
5TH PERCENTILE
50TH PERCENTILE
95TH PERCENTILE

ANNEXURE VI


WEIGHT FOR AGE PERCENTILES FOR GIRLS AGED 11-18YEARS
PERCENTILES
60
50
40
30
20
10
0
11
12
13
14
15
16
17
18
AGE IN YEARS
3RDPERCENTILE
50TH PERCENTILE
97TH PERCENTILE

ANNEXURE VII